HAMILTON. [J.B.]

GANGRENE.

Gamboge has been used in China and India as a pigment for many centuries, and appeared as a purgative in Europe early in the seventeenth century. Its use in medicine, however, has always been insignificant in comparison with its consumption as a yellow paint, for which use it is hardly excelled by any pigment.

The best of that which reaches us is almost always in the form of bamboo casts from three to five centimetres (1 to 2 inches) in diameter and from one to two or three decimetres long; the surface is longitudinally striated, the color deep-orange, the fracture conchoidal. Fresh specimens are often pliable and may be variously curved; old and dry ones very brittle. The odor, when moist, is peculiar, the taste sharp and acrid. It does not dissolve in water, but forms a very fine, smooth, yellow emulsion with it. Soluble in part (the resinous) in alcohol, wholly in solutions of potash. It should be free from starch and much coarse impurity.

Gamboge contains about seventy-two (Christison) per cent. of yellow resin called *Gambogic acid*, an orange-yellow, tasteless and odorless mass, soluble in alcohol and ether, but not in water, having the purgative properties of Gamboge, but less intensely than the crude gum-resin itself. It also contains fifteen or more per cent. of *gum*, a little water, and some impurities.

Action and Use.—This is one of the most violent of hydragogue cathartics, producing abundant watery stools and considerable griping, on which latter account it is not often now given alone, or for its full effect. It is, however, frequently added in small doses to the other cathartic combinations, and experience has proved its usefulness.

Administration.—The full dose of Gamboge is about 0.3 Gm. (= gr. v.), but less is advisable in compositions; the maximum daily quantity is stated by the German Pharmacopœia to be a gram. It is an ingredient in the compound cathartic pills (*Pilulæ Catharticæ Compositæ*, U. S. Ph.), each of which contains a quarter of a grain.

Allied Plants.—Besides the several gamboge-yielding trees the genus contains also the Mangosteen (*G. indica* Choisy), from the seeds of which the fat called Kokum Butter is expressed. The order contains little else of commercial importance.

Allied Drugs.—Euphorbium, Podophyllum, Scammony, Croton Oil, and a number of other irritant purges. For other vegetable coloring matters, etc., see Saffron.

W. P. Bolles.

GANGLION. The term ganglion is used to designate, on the one hand, the well-known enlargements of the sympathetic nervous system, and on the other, certain swellings most frequently observed in connection with joints and tendons. In this article the word is employed in the latter sense. A number of somewhat different affections are commonly included under the head of ganglion. We may distinguish between three varieties of these formations:

1. *Simple Cystic Ganglia.*—French writers speak of this variety as follicular ganglia, on the supposition that they take their origin from the alleged follicles of the synovial membranes of the tendons (*follicules synovipares*). They really represent cystic formations with colloidal contents, which occur in connection with the sheaths, chiefly of the flexor tendons of the fingers. These ganglia rarely attain a size larger than that of a pea. They are sometimes found in connection with the capsules of the smaller joints.

2. *Articular Ganglia.*—Abnormal protrusions of articular synovial membrane, containing a serous fluid, generally constitute this variety of the swellings in question. Sometimes, however, articular ganglia are formed by a serous distention of preformed, or so-called secondary or accidental, bursæ mucosæ.

3. *Tendo-vaginal Ganglia.*—This is the most frequent variety, and may be regarded as a hernia of the sheaths of a tendon. The origin and pathology of these swellings is readily understood when we remember the anatomy of the tendo-vaginal structures. They are composed of a double membranous layer, of which the one nearest the tendon constitutes a synovial membrane, whereas the outer one is a mere fibrous expansion. Since the latter does not, in all places, form a complete covering for the former, it is clear that hernial protrusions are invited. It is for this reason also that ganglia are so frequently seen on the back of the hand, and more particularly so at the wrist, where the great number of tendons, taken in conjunction with the frequent strain of manual exertion, favors a protrusion of the synovial portion of the tendon-sheaths.

Ganglia are usually of slow growth, and rarely attain a size larger than that of a walnut. Their presence occasions but little discomfort to the patient. Some weakness of the muscle involved, a feeling of local tension, and occasionally painful sensations, are the chief complaints. Patients generally seek medical advice more on account of the visible deformity than for any other reason. Of course, a ganglion may become inflamed, and then violent symptoms will be observed.

The contents of the swellings consist of a colorless or yellowish gelatinous substance. The so-called melon-seed bodies, or rice-water granules, are scarcely ever found in connection with them, a point which marks a frequent distinction between ganglion and ordinary hygroma.

There is no difficulty about the diagnosis of ganglia. Their location, their contents, the history of their development, their round or ovoid shape, their painlessness, their tense elasticity, at once indicate the nature of the swelling. But as regards the particular variety of ganglion we are dealing with, matters are often far from easy. In a general way, the seat of the protrusion will aid our judgment. It may also be said that, if continued gentle pressure causes the swelling to diminish in size or to disappear entirely, then it is most likely to be an articular ganglion. But this phenomenon is not an infallible sign of the nature of the swelling.

The treatment of ganglion will vary with the circumstances of the individual case. The old method of producing rupture by pressure is still much in vogue, and may safely be tried. If the cyst be thin-walled it generally succeeds, although recurrence of the swelling is not at all unlikely. All force and violence are to be deprecated, however, on account of the danger of subsequent spreading inflammation. Subcutaneous incision, or discission (*i.e.*, section with laceration of the sac), are applicable to those cases that do not yield to pressure. The most radical way to deal with these swellings consists in open incision or excision. With the observance of modern antiseptic precautions, the old dangers of synovitis, suppuration, and the like, need not be dreaded any longer. The cure following these operations is a permanent one.

Edmund C. Wendt.

GANGRENE. Definition.—The word *gangrene* is now held to mean death of a soft part. When a bone dies, or any part of it is deprived of life, the term *necrosis* is used. There is some confusion in the literature of the subject as to the nomenclature of this condition. The terms mortification and sphacelus are now used as synonyms, but formerly, in the usage of many writers, the word mortification was held to include, as subdivisions, gangrene and sphacelus—gangrene, according to Mr. Liston, being "that state in which the larger arterial and nervous trunks still continue to perform their functions," and the part is "supposed still capable of recovery," and sphacelus the condition of "complete death, when putrefaction being no longer resisted, the part becomes black, cold, insensible, and fetid." This was the view held by Heister (1740), and by John Pearson (1788), who incidentally mention the term mortification, but speak of gangrene and sphacelus as synonyms, to which the ancients gave the term *cancrum* (Celsus). It is doubtful if this use of the term sphacelus is sanctioned by the best classical authority, for it is certain that, in describing sphacelus of the brain, Hippocrates described ramollissement and not gangrene; however, the moderns have now adopted the term in its generic sense, and the confusing synonyms are rapidly becoming obsolete.

Varieties.—The varieties of gangrene are: moist gangrene; dry gangrene; senile gangrene; "white" gan-

grene; "symmetrical" gangrene; "diabetic" gangrene; "diphtheritic" gangrene; noma; and "hospital" gangrene.

ETIOLOGY AND PATHOLOGY.—A general division of the causes of gangrene into traumatic and idiopathic may be made, but it is evident that, whether the local death of a part is produced by mechanical violence or by disease, the cause must be the same; namely, an interference or arrest of the nutrition of the part. These causes are referred to obstruction of the circulation, with the exception of those cases of epidemic gangrene described by the ancients, and the modern cases of hospital gangrene. Nutrition is interfered with, or arrested, by *obstruction in the arteries*, such as occurs in cases of gunshot wounds; ruptures by mechanical violence; compression or ligature; by disease of the arterial coats; by pressure of a tumor in the adjacent tissues, or by a thrombus; by *obstruction in the capillaries*, which may produce complete anæmia of the part, from pressure upon the capillary walls by tumors, extravasated blood or fibrin, or through fatty metamorphosis of connective-tissue corpuscles (Wagner), or by superficial pressure from bandaging. The observation that tight bandaging would occasionally produce gangrene is as old as Hippocrates, who distinctly refers to it. Anything, therefore, which will produce stasis in the capillary, of long continuance, whether by mechanical violence, inflammatory change, the internal administration of certain drugs, or the action of chemicals, must necessarily result in gangrene; or by *obstruction in the veins* sufficient to entirely prevent the return circulation.

Let us now examine these causative states somewhat in detail. Obstruction to the arterial circulation occurs in consequence of gunshot, lacerated, and incised wounds, whenever the artery is torn or cut, and this obstruction results in gangrene whenever the collateral circulation fails to become established. The plates accompanying this article, from the "Medical and Surgical History of the War of the Rebellion," show cases of this kind with great distinctness. Pressure upon arteries during the treatment for aneurism has also produced gangrene. Surgeon Fessenden, of the Marine Hospital Service, has reported a case[1] where compression was applied to the popliteal artery, just above an aneurism of that vessel, for one hour, when pulsation ceased in the tumor; three days later, it was noticed that sensibility was lost in the foot and leg, which became very much discolored, and there occurred blebs on the foot; a day later the entire foot and leg were gangrenous, and amputation was performed. Coagula (*thrombi*) may form in the arteries as a result of chronic endocarditis, or endarteritis, or even fatty degeneration or calcification of the arterial coats (Wagner). The embolus may lie near the gangrenous spot, but frequently far away from it. Acute inflammation of the arteries occasionally produces fatty degeneration, and it in turn, by reason of the loss of contractility of the vessel, allows a thrombus to form through sluggishness of the arterial circulation; finally, stenosis of the vessel may occur (as in the pulmonary artery), and gangrene of the dependent tissues result.

Obstruction to the capillaries is a prolific source of gangrene, and if those cases are included where stasis is produced at the veniole, it may be said to include nearly all the cases not directly dependent on arterial obstruction for their causation, exclusive of the phagadenic varieties under the head of hospital and epidemic gangrene. It is in the capillaries that the effect of diminished cardiac power is most manifest, especially in the parts remote from the heart. Chronic exhaustive diseases, senile and general debility, therefore, are important factors in the production of gangrene. Gangrene from the administration of ergot is produced by the effect of the drug on the arterioles through the vaso-motor nerves, whereby these vessels are permanently diminished in calibre. The experiments of Holmes (1870) showed the effect of ergot upon animals to be manifested in the capillaries, as witnessed in frogs, and Péton (1878) observed the contraction of the retinal vessels in man. Péton believes that this effect is produced, independently of any influence upon the vaso-motor system, by the direct action of the drug upon the muscular fibres. Nikitin (1878), however, denied this, and his investigations have led him to confirm the usually accepted theory.

Ergotism, as a cause of certain epidemics of gangrene in man, was first described by Dodard in 1676, then by Saviard in 1694, and by Noel in 1710. The disease appeared in Switzerland in 1676, according to Langius and Quassond. It also appeared in Dauphiné in 1709. Duhamel, in the "Mémoires de l'Académie Royale de Paris" for 1748, states that the disease was accompanied with very great mortality, "not more than four or five out of one hundred and twenty who had been attacked escaped with life." Péreira (1840) thinks this affection was known from a still earlier period, and quotes a passage from Sigebert to support his views (South); "1089, a pestilential year, especially in the western parts of Lorraine, where many persons became putrid in consequence of their inward parts being consumed by St. Anthony's fire. Their limbs were rotten and became coal-black, they either perished miserably, or, deprived of their hands and feet, were reserved for a more miserable life." It is stated that "the bread which was eaten at this period was remarkable for its deep violet color."

Notwithstanding the general concurrence of opinion as to the effects of ergotism on man, it has often been denied that it produced any such effect upon animals. Block, in 1811, fed nine pounds of ergot daily to twenty sheep, for four weeks, without any visible effect, and twenty sheep of another lot ate thirteen and a half pounds daily, for two months, without injury. Thirty cows took twenty-seven pounds daily for three months, and the only apparent effect was to injure the quality of the cream (Péreira). Tessier, however, in 1776, visited those countries in which the epidemic had prevailed, or was then present, and found that, although the quantity necessary varied, yet it finally produced the gangrenous affection ("Mémoires de la Société Royale de Médecine," 1776 and 1777–78). Instances are not wanting of the prevalence of gangrene as an epidemic among animals in the United States. Dr. Salmon, Chief of the Bureau of Animal Industry of the Agricultural Department, in a recent report on this subject (1885), has shown conclusively that many so-called epidemics of the "foot and mouth disease" of cattle are really epidemics of ergotism. He found much ergot in the heads of "red-top" grass, timothy, and in the chess or "cheat," as well as in rye; and in the particular epidemic in Kansas which called out the inquiry, the ergot was found in the hay fed to the diseased animals in the proportion of about one to every seventy-five pounds. In these cases there were sloughing ulcers of the mouth, ulcers in the rectum, with diarrhœa, a temperature of 101° to 104° F., and a line of demarcation above the hoof—in some cases as high as the middle of the leg, and not infrequently the ends of the tails became gangrenous and dropped off. In an exhaustive review of the history of epidemics of gangrene from ergotism, Dr. Salmon cites many instances to show that nearly all the domesticated animals have suffered from the effects of this poison. As bearing upon the question of treatment, it is interesting to note that Dr. Salmon considers that ergot in hay may be prevented by cutting the grass before the seeds have formed.

The first effect of extreme cold upon the tissues is the contraction of the capillaries to the smallest practicable degree. A certain amount of blood serum is actually frozen and the capillary is ruptured, the circulation is not resumed when the parts are thawed, and gangrene results. Gangrene thus produced is usually of the dry variety, although, when the venioles or the larger venous trunks are frozen, by reason of the failure of the return circulation, moist gangrene is produced. Direct destruction of cells by caustic chemicals may produce gangrene of distal parts, through failure of both supply and return of blood. Gangrene of the perineum may occur from extravasated urine (Green, 1884), as even normal urine is highly irritating; but in such cases there must have been antecedent local inflammation, and the death of the exudate precedes the death of the adjacent cells. Urine

which has undergone putrefaction, being loaded with the putrefactive bacteria, is much more speedy in its action, especially as the tissues themselves are weak in their power of resistance; while not absolutely devitalized, they are yet in a state of extreme inertia. It is well known that the power of resistance to the entrance and subsequent development of the pathogenic bacteria is variable, and that, for instance, in cases of convalescence from such exhaustive diseases as typhoid, typhus, and the severer exanthemata, fatal forms of so-called blood-poisoning are apt to make their appearance; this condition, while perhaps immediately dependent upon diminished cardiac power, is one of deficient innervation; for insufficient nutrition of the nerve-centres is necessarily manifested in weakness of muscular tissues throughout the body.

Obstruction of the veins, it will be seen, is very rarely a direct cause of gangrene; pressure or occlusion of the superficial veins alone will scarcely produce it, unless there is constitutional predisposition, as above set forth, for the deep veins will still carry away a large share of the return blood-current. When gangrene does result from compression or ligature of superficial veins, it is by the production of stasis in the capillary; to this cause we must refer the cases produced by tight bandaging, and, indeed, all of similar character, except those of venous thrombi. It thus appears that the starting-point of all our studies of the pathology of gangrene must be at the border line between the arteriole and the veniole, that hypothetical point termed the capillary. Those cases of gangrene following punctures in the skin to relieve the tension in cases of dropsy have their origin in the arteriole and veniole. "Here the blood-vessels of the skin are already very much stretched by the fluid collected in the superficial fascia, and the nutrition of the integument is impaired in a corresponding degree. There is an immediate effort to repair the wound, but the afflux of blood to its margin lacking sufficient cardiac impulse, stagnates at once, and the enfeebled tissue, unable to react under the stimulus of the effort, dies forthwith in the stage of stasis, from entire stoppage of its nutrition" (Van Buren: Lectures, edited by Stimson, 1884). Finally, we may have gangrene from total disorganization of tissue elements; the *gangrène foudroyante*, such as occurs in severe crushing injuries, as well as in internal parts deeply bruised, such as the cervix uteri, vagina, and vulva after severe labors (Wagner).

Moist Gangrene.—This form of gangrene, also called acute gangrene, hot gangrene, inflammatory gangrene, is always preceded by inflammation. The part is at first swollen and painful, there is almost always inflammation of the veins (phlebitis), and the moist condition depends upon the obstruction to the return circulation, by which the water is left in the tissues.

Symptoms.—The history of an injury, and of antecedent inflammation, absence of pain in the part, although in the parts adjacent, where the inflammatory blush is present, the pain will be acute. Characteristic changes in color, at first livid, then bluish, and finally completely black; swelling which is boggy to the touch (œdematous), sometimes accompanied with emphysematous creaking. This emphysema is due to the development of gases, loss of temperature, and complete destruction of function. It is sometimes said that sensation is not destroyed, but this, when present in appearance, is only the well-known phenomenon of the sensation in a wounded or severed nerve being felt as of its peripheral extremity. In the beginning the odor is imperceptible, but as the putrefactive change progresses, the odor is "sweetish," and finally stinking in the highest degree. Constitutional symptoms are usually present, such as suppurative or hectic fever (septicæmia), and in advanced stages of this fever it may be characterized by great prostration, even collapse; diarrhœa may be present, and in exact proportion to the degree of fever, there are the profound rigors and profuse sweatings of pyæmia; but if the gangrene is not extensive, and is well localized, there may be little general disturbance. In cases where the disease is protracted, the septic fever pursues its usual course, and the well-known typhoid condition of the system is present, the various symptoms of which need not be here described. There is little difficulty in the diagnosis of this affection, but in the lax condition of the skin of the aged, with its enfeebled circulation and diminished vitality, there is sometimes doubt whether the blackness of the surface is due simply to ecchymosis or to gangrene. I recently met with the case of an aged lady, who had sustained a fracture of the elbow-joint, in which it was scarcely possible to determine, for a period of nearly two days, whether the blackness was a sign of gangrene or not. On careful inspection, however, the blackness seemed to entirely underlie the skin, and in a day or two the successive changes of the blood spectrum became apparent, the blue-blackness giving way to violet and lemon yellow, and then normal. When the extension of the gangrene becomes arrested there is seen, encircling the part, a series of vesicles, or sometimes a mere line of redness. This redness becomes deeper, the epidermis over it falls off, the dead part begins to shrink away, and nature commences, by the rapid consolidation of the inflammatory exudate, to prevent further absorption by the lymphatics of any septic material. This line of redness, termed the "line of demarcation," is a narrow band of granulation tissue, which conforms to all other granulation tissues in being devoid of lymphatics, hence there is no absorption from them. The line of demarcation gradually extends entirely to the bone, in case an extremity is involved, and the dead soft part finally drops off. So long a time is required for the bones to undergo this process that they are usually seen protruding, and the case is seldom left to nature beyond this point.

Treatment.—When gangrene is threatened, the treatment should be directed toward its prevention, therefore the inflammation should be combated, the return circulation favored by massage and external heat. There is no single remedy so generally applicable, and so prompt in its effects, as external heat; the part, after gentle friction, may be enveloped in hot flannel, frequently changed, bottles of hot water applied, or, if circumstances indicate a preference for irrigation with hot water, that plan may be adopted, but it must be as hot as can be borne, to be of service. Thus the feeblest circulation may often be encouraged so that it once more becomes strong, and its effect in keeping alive the collateral circulation in cases where the main artery is occluded from injury, operation, or disease is beneficial in the highest degree. The old axiom that "heat is life, and cold is death," is nowhere more applicable than in these cases. Where stasis is manifest by the œdema, and boggy feel of the tissues, broad punctures, deeply through the tissues, are of great service. The patient should be supported with tonic and stimulant remedies according to individual judgment. When the gangrene has become complete, local remedies are of no avail except to favor the production of sloughs, hasten the separation, and, by the use of antiseptics, to render the odor less offensive. Among these may be mentioned dilute pyroligneous acid, solutions of bromine, Labarraque's solution of chlorinated soda, and the solution of the bichloride of mercury. Carbolic acid, so frequently recommended, as well as iodoform, is quite as offensive in odor to some as the putrefying mass itself. The mass can be rendered quite innocuous by deep injections of the bromine solution. When the line of demarcation is fully established, operative interference is then demanded. The rule is, with two exceptions to be hereafter noted, to await the line of demarcation before performing an amputation. The gases formed by the putrefactive decomposition of the dead tissue are not poisonous, they are nauseous and offensive, but not rapidly disease-producing; therefore, while the tissues above the obstruction point are gaining strength and recuperative power, the surgeon may well stay his hand. The exceptions are in those crushing injuries where the bones and soft tissues are bruised, lacerated, and torn, and the arterial supply is cut off. Amputation is then immediately necessary. Again, in those cases of gangrene following an injury, where the gangrene seems to be self-propagated and extends beyond the point of injury, and

the patient is rapidly failing under the septic fever; in such cases, happily very rare, amputation is demanded.

Dry Gangrene.—In this form of gangrene there is neither venous obstruction, nor failure of the lymphatics, and the fluids of the part are carried back into the system as fast as formed. As the arterial supply is gradually cut off, a drying or mummification of the tissue results. This condition frequently occurs in those suffering from starvation; in those subject to gout (Chelius); or those who have exhausted themselves by excessive debauchery. There is frequently an absence of inflammatory symptoms, and it may come on suddenly without premonition. There is usually organic disease of the heart and arteries. This is the chronic gangrene of Travers (South).

Symptoms.—Corrugation and shrinking of the soft parts, and gradually deepening color, until the whole mass is of a coal-black; pains of varying severity usually precede the discoloration, sometimes lasting for several weeks. Occasionally pain is absent, and the patient simply experiences a sensation of numbness and coldness in the part. As the gangrene progresses, constitutional symptoms are manifested, there is great mental depression, unquiet sleep, palpitation of the heart, epigastric pain, and occasionally an intense internal cold (Chelius). Sometimes the distinctive characteristics between dry and moist gangrene are so obscure that it is difficult to place the case in one class or the other

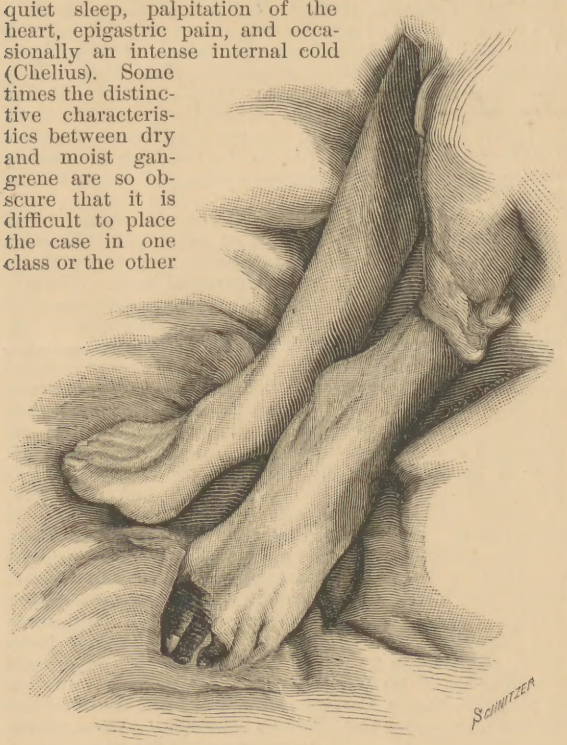


Fig. 1379.

(Moore: "Int. Encyclo. Surgery," 1882). The remarks in the preceding page, relative to the treatment of moist gangrene, are equally applicable here, except that the powers of the system require a more supporting plan of treatment. As to operative interference, it is proper in all these cases to await the line of demarcation. The prognosis is unfavorable.

Senile Gangrene.—This gangrene, which is usually of the dry variety, is almost wholly due to arterial obstruction, the pathology of which has already been discussed; but the obstruction is long in forming, and the progress of the disease is slow. The description by Percival Pott of the affection, as it occurs in the foot, was so striking that for a long time it was known as Pott's disease of the toe; but, as the disease occasionally attacks the hands, the name was manifestly inappropriate. The condition of the arteries in these cases is one of "ossification" or calcification, which results in a complete loss of elasticity, and consequent diminution of the blood-supply. The bead-like feel of the radial pulse, in the aged, gives the observer a palpable object lesson in senile calcification. The statement has been made that certain seasons specially predispose to senile gangrene, and the winter is alleged to be that season most favorable to its production, owing to the astringent effect of the cold; but there are no statistics to bear out this assertion, and the writer considers the case by no means made out.

Symptoms.—After some months or weeks of pain, or otherwise unpleasant sensation in the part, a small bluish spot appears on one of the toes, frequently at the root of the nail, and the spot becomes black; from this point the discoloration slowly spreads to the adjoining toes, and finally, if the patient survive long enough, the whole foot and leg becomes involved. Sometimes the line of demarcation is formed near the centre of the foot, but more often the patient succumbs under the combined influence of the nervous exhaustion produced by the pain and the failure of the digestion. The pain accompanying the disease is a prominent symptom, and gives the patient more immediate concern than the fear of losing the limb, or even life itself. The figure opposite, from a photograph of a patient under my care at the Providence Hospital, shows the stage of the disease at the time of her death. The notes are as follows: Elizabeth B——, aged eighty-five, admitted to hospital April 13th, for a contusion of the knee, which, however, had left no trace; the pain in the toes and foot was constant and harassing. Three weeks later a blue spot was noticed on the dorsum of second toe. The spot gradually spread to include the great toe, as shown in the photograph, and the patient died July 20, 1885.

Treatment.—This has been well formulated by Van Buren (*loc. cit.*): "The treatment of senile gangrene is limited to a judicious husbanding of the patient's vital resources, looking to a possible self-limitation of the disease, after which a cure may be completed by amputation." To husband the patient's resources it is necessary, along with stimulating and supporting measures, to control the pain; here there is nothing more philosophical in its action than the hydrochlorate of cocaine injected into the painful tissue. Percival Pott claimed curative power for opium, but not only has this treatment failed in the majority of cases, but it actually hastens the fatal result by impairing the digestion. The cocaine, on the contrary, frequently subdues the pain at its seat, and does not derange the stomach. Even its external application has been found beneficial, but it is manifestly less powerful than when used hypodermatically. In these cases, as in the foregoing varieties of gangrene, external heat will be found advantageous.

"White" Gangrene seems to be simply a moist gangrene of chronic form, in which there is a serous exudate, with lymphatic obstruction, followed by complete anæmia; the exudate dying, the parts are filled with pus. The condition scarcely deserved to be called a separate variety of gangrene, but as it is unaccompanied with the characteristic color-change of other varieties of gangrene, the distinction is made. Rokitansky applies the term to the sloughs themselves. The *treatment* consists in free incisions, anodynes, and external heat. As this disease occurs in the younger ages, the prognosis is more favorable.

Symmetrical Gangrene (Relapsing Gangrene).—This affection, probably first accurately described by Raynaud ("De l'Asphyxie locale et de la Gangrène symétrique des Extrémités," 1862), is exceedingly rare, Billroth, up to 1872, having met with a single case, and other observers with extensive experience having seen no example. According to Raynaud, the disease occurs chiefly in chlorotic and nervous individuals of early adult life, patients in convalescence from typhoid fever, and similar exhausting disease. Moore ("International Encylopædia of Surgery") has seen a case presumably from this cause, and the appearance of the case is shown in the illustration accompanying this, from Dr. Moore's article.

"The disease most frequently attacks the fingers—rarely the toes, tip of the nose, and external ear; often, for months beforehand, the affected parts suddenly become white, bloodless, without feeling, dead; the skin is

strongly wrinkled and shrunken, the ends of the fingers appear thin and conical. The temperature of the parts is sunken, and the muscular movement is as though paralyzed. If this state extend over a whole extremity, the pulse becomes imperceptible. After a variable time there follows a painful reaction; itching arises, and the feeling of overfilling of blood; the skin becomes bluish-red. Severe pains precede the proper outbreak of gangrene. The extremities become bluish-white, violet, dark, livid, marbled; they are insensible, but very painful, and icy cold; then small vesicles appear which fill with serous-purulent liquid, and are usually destroyed, so that the cutis becomes laid bare. Even now, the part may be restored; but for the most part, after a time the attack returns, and then the fingers show numerous small, white, depressed, and hard cicatrices on their extremities, which are found specially in front of and beneath the nails, and form conical callosities. If the ischæmia is of longer duration, there follows from the consecutive hyperæmia a true mummification, which terminates with the falling off of the last phalanx" (Wagner).

This form of gangrene is, as will be seen, entirely distinct from that form of double gangrene of both lower extremities resulting from embolism of the abdominal aorta at its bifurcation.

Diabetic Gangrene.—The impoverished condition of the blood in cases of diabetes mellitus favors the production of gangrene, and it has been specifically named as a variety, although without any very good reason. As well might gangrene occurring in the progress of any chronic disease be separately named, and in most articles on the subject of diabetes the occurrence of gangrene is mentioned as among the complications of that disease. "Spontaneous gangrene of the lower extremities, with obstruction of one or more arteries of the limb, is not infrequent in diabetes" (Marchal de Calvi). "Ulcerated surfaces are slow to heal, and gangrene supervenes sometimes spontaneously, but more often as the result of some trifling injury" (Tyson: Pepper's "System of Medicine," vol. ii.). The treatment of gangrene, when it occurs as a complication of diabetes, does not present any striking variations from the general treatment of the disease elsewhere, or any cause to vary from the treatment necessary from that proper for the diabetes.

Diphtheritic Gangrene.—This form is usually named as one of the varieties, but, like the last-mentioned, has no valid claim to be considered as a distinct affection. By some, indeed, it is considered as gangrenous diphtheria, by others as a variety of hospital gangrene. Diphtheritic patches resulting in gangrene are sometimes seen in the edges of the sore resulting from the incision in tracheotomy; and when hospital gangrene is present in a hospital ward, wounds are frequently seen with the tough, fibrinous diphtheritic patch springing therefrom. In these cases the constitutional poisoning seems more severe, but whether on account of the increased number of micrococci present in the blood or not is not known. The question of the influence of bacteria in the production of gangrene in any of its forms is yet unsettled, and in regard to diphtheria, although examined with the greatest skill and enthusiasm, the question is no nearer solution (Jacobi). Jacobi (Pepper's "System of Medicine") quotes approvingly the words of the late Professor Panum: "We have but a feeble insight into the relations between these organisms and diseases, and in order to effect that much desired advance in scientific knowledge—a matter of considerable importance in the practice of medicine—it is necessary not only to grasp at isolated data, but carefully to observe and study all the facts before us, and even to devote some attention to those which would tend to prove that there are bacteria and fungi which, under certain circumstances, are perfectly harmless, and that even some of the malignant ones among them do not commit all those outrages with which they are charged, directly and personally."

The treatment of diphtheritic gangrene is the same as that of hospital gangrene, which will be mentioned in detail.

Noma.—This is a gangrene affecting the pudenda and cheeks of young children from the age of weaning to that of puberty. Nurslings seem to have an immunity from it. When confined to the cheeks and mouth, it is variously termed *gangrenous stomatitis, gangræna oris, cancrum oris, gangrenopsis-stomato-necrosis, necrosis infantilis, buccal anthrax, water canker, sloughing phagedena* of the mouth, and by the Germans *Noma* and Wasserkrebs; by the French *gangrène de la bouche*. The disease has been known for a long period, and was first described by Carolus Battus, of Amsterdam. Van Sweiten (1699) recognized the disease as gangrene. Wiseman (1676) mentions the disease as Noma, which he describes as "a deep Ulcer that eats and spreads without Tumor, but hath a Rottenness and Putrefaction joined with it."

The disease is attended by great mortality, but as it usually comes on while the patient is suffering from some other affection, it is difficult to determine its relative fatality with precision. The affection, whether it appear on the mucous surface of the cheek or on the vulva, is almost invariably unilateral. It begins as an inflammation attended by great exudation, ulceration is set up, the exudate dies, and the general appearances of circumscribed gangrene, due to obstruction of the arterioles, are present. In the mouth the disease usually begins at the frenum of the lip, but rarely on the outside of the cheek (Chelius), and as the œdematous inflammation extends the ulcerative process is carried down to the bone, and alongside of the nose, and frequently involves the whole Schneiderian membrane. Occasionally the disease begins on the gums at the alveolar border (Cohen). At the pudenda the disease usually commences at the labial margin, and extends to the clitoris, nymphæ and hymen, and sometimes to the urethra, when the pain in micturition is acute; the inflammation is rapid, and the tissues speedily fall out by sloughing, the disease spreads to the perineum, to the anus, the thigh, and to the mons veneris, and, as is the case when in the mouth, the sloughing is deep and frequently extends quite to the bone. Sometimes the affection beginning at the mouth is later on developed at the vulva, and frequently the noma is ushered in with general constitutional symptoms, such as rigors with fever; but, more commonly, its onset is masked by the particular affection from which the child has been suffering; but always, in the later stage of the affection, there is great prostration, with feeble pulse, and chlorotic countenance. When the affection is on the pudenda, there is great pain in all movements of the lower extremities, and the child usually assumes of its own accord the dorsal decubitus, and the legs are widely separated. There is retention of urine, owing to the severity of the urethritis, and constipation. There is rapid emaciation, and the patient sinks under the "typhoid condition" so constantly present in the later stages of the other forms of gangrene. Cohen remarks that pulmonary gangrene is often observed in the noma of the mouth as a complication, and frequently entero-colitis. When noma affects the mouth alone, there is great variability in the degree of constitutional sympathy, some patients being able to sit up and play, while others are hopelessly comatose from the outset. The contagion of the affection was claimed by the old Dutch writers who witnessed epidemics of gangrenous stomatitis, but modern observation does not approve the theory of its contagion or inoculability. Hæmorrhage from the facial, or from the pudendal branches of the pudic, may occur, but in this variety, as in other forms of gangrene, the arteries are plugged by thrombi long in advance of the loss of tissue. The treatment of noma is both local and constitutional; both are important, and neither can be safely neglected. The local treatment is the same as that recommended for hospital gangrene, and will be again adverted to. Quiniæ sulphate in full doses, with the tincture of iron, should be kept up until the appetite is good and the tongue becomes normal in appearance. In case the stomach will not bear the continued administration of the tincture of iron, or it produces much headache, owing to increased cerebral tension, the potassium chlorate should be substituted. Milk-punch and liquid food are always indicated, and it may be necessary to use nutritive enemata. The patient should be placed in a

well-heated, well-ventilated apartment, with plenty of sunshine.

Hospital Gangrene.—It only remains, in concluding the subject of gangrene, to discuss that form of the affection known as *hospital gangrene*, *hospital phagedena*, *gangræna nosocomialis*, and *pourriture des hôpitaux*. Although the modern teaching is that hospital gangrene is a preventable affection, and will not occur in any hospital where proper attention is paid to cleanliness and disinfection, yet it is well to remember that the disease sometimes appears, in all its essential characteristics, in cases quite remote from hospitals, who had apparently not been exposed to contamination from any other patient (Billroth). The disease is now rarely seen in hospitals, but as the neglect of careful attention to the avoidance of the causes of the spread of the disease might once more render it prevalent, it is well to remember that it was once one of the most common complications of wounds, and its history was marked by a fearful mortality; and so inseparable was the disease once assumed to be from hospitals, that Poteau (1783), the first historian of the disease, himself a sufferer from it, in his earliest description says of the hospital air, "au mauvais air qu'on respire dans les grands hôpitaux," and he proposed the inquiry whether, in view of the facts, "hospitals were not more pernicious than useful to humanity?" But it is now known that wherever hygienic laws are violated, wherever wounded men are crowded together in ill-ventilated hospitals, with insufficient food, insufficient warmth, and lack of cleanliness, hospital gangrene is apt to show itself; and that a single case in such circumstances affords the nucleus for the spread of the disease, and the development of an epidemic. Mr. Blackadder (1818), indeed, claims that under such conditions the disease has been known from the earliest times, and cites passages from Celsus, Aetius, Paulus Ægineta, Rolandus, Guido, and others, to support the statement. In modern wars the relation between the hygienic cause and effect has been carefully studied by Ballingall, McLeod, Guthrie, Joseph Jones, and others. McLeod, who observed the disease at Scutari, in the Crimean war, observed that there was a great increase in the affection when the sirocco blew, that the atmosphere was surcharged with electricity, and that wounds generally assumed an unhealthy aspect for days when this pestilential wind prevailed. Chisholm ("Manual of Military Surgery for the use of Confederate Surgeons") states that he witnessed an epidemic of hospital gangrene in Milan in the summer of 1859. "A large number of Austrian wounded had been put in a barrack; they had undergone many hardships, retreating daily before a victorious enemy, and had, prior to the battle of Solferino, tasted no food for forty-eight hours. They had been deceived by their leaders, who had taught them that certain death awaited them should they fall into the hands of the Italians. With these impressions, the wounded hid themselves in the ditches and underbrush of the battle-field, where many perished. Some were not discovered for two or three days, when they were sent to the hospital. The previous hardships they had undergone, their lymphatic tendencies, their irregular living, with the moral depression of repeated defeat, exposed them to the ravages of the lowest forms of the disease. Many of their wounds were frightful from the extensive sloughing, and their worn frames and gaunt visages indicated a fearful combat with the disease. I was particularly struck with the mental depression under which many of them were suffering—amounting to despondency." Dr. Joseph Jones had an opportunity of studying the disease on a larger scale than any of his predecessors. He not only made special investigations on the "dejected, debilitated, diseased, and filthy prisoners crowded into the foul prison and hospital at Andersonville, Ga.," but also investigations into all cases that occurred throughout the Confederate service; and made numerous experiments on animals. His observations ("Memoirs U. S. Sanitary Commission, Surgical Volume II." N. Y., 1871) confirm the previous theories of the predisposing causes of the disease, and put at rest the doctrine of the inoculability of the virus. Although it had long been known that certain old lint, sold from the Paris hospitals in 1797, had been washed and carried to Holland, where every ulcer to which it was applied subsequently became affected with hospital gangrene, and the experiment of M. Ollier, in 1810, by self-inoculation of the virus, had proved its inoculability, yet there have not been wanting those who denied every principle of contagion to hospital gangrene. Even so late as 1863, the editor of the American edition of Wagner's "Pathology" expressed doubts on the subject, and twice inoculated himself with the products of hospital gangrene without effect. The remarkable immunity in this case, however, must not be taken as conclusive evidence of the harmlessness of the poison, any more than the eating of trichinous pork by Drs. Belfield and Atwood proved that infected pork was a wholesome article of diet. The experiments of Joseph Jones, in the successful inoculation of animals, and the instances of the carrying of the contagion in sponges, have set the matter at rest, and its contagious quality is now admitted.

Symptoms.—These are variable. Mr. Guthrie graphically describes them: "A wound attacked by hospital gangrene in its most concentrated and active form presents a horrible aspect after the first forty-eight hours. The whole surface has become of a dark-red color, of a ragged appearance, with blood partly coagulated, and apparently half putrid, adhering at every point. The edges are everted, the cuticle separating from half to three-fourths of an inch around, with a concentric circle of inflammation extending an inch or two beyond it; the limb is usually swollen for some distance, of a white, shining color, not peculiarly sensible except in spots, the whole of it being œdematous or pasty. The pain is burning and unbearable in the part itself, while the extension of the disease, generally in a circular direction, may be marked from hour to hour; so that, in from another twenty-four to forty-eight hours, nearly the whole of the calf of a leg, or the muscles of a buttock, or even the wall of the abdomen, may disappear, leaving a deep great hollow or hiatus of the most destructive character, exhaling a peculiar stench which can never be mistaken, and spreading with a rapidity quite awful to contemplate. The great nerves and arteries appear to resist its influence longer than the muscular structures, but these at last yield; the largest nerves are destroyed, and the arteries give way, frequently closing the scene, after repeated hæmorrhages, by one which proves the last solace of the unfortunate sufferer. . . . The joints offer little resistance; the capsular and synovial membranes are soon invaded, and the ends of the bones laid bare. The extension of this disease is, in the first instance, through the cellular structures. The skin is undermined and falls in, or a painful red, and soon black, patch is perceived at some distance from the original mischief, preparatory to the whole becoming one mass of putridity, while the sufferings of the patient are extreme."

The surface of the wound soon becomes a sticky, pulpy mass of a grayish color. This substance cannot be wiped off, and it resists the usual washings. If, at this stage, the further progress of the disease be not arrested, the patient succumbs, as from a fatal form of septicæmia.

Treatment.—The local treatment of hospital gangrene has now become sufficiently simple owing to the introduction of the use of bromine by Dr. M. Goldsmith, a medical director of volunteers in the United States Army during our last war.

Dr. Goldsmith found that when the wounds affected with hospital gangrene were thoroughly cauterized with bromine, not only was the disease arrested, but the dissemination of the vapors of the drug through the air of the ward materially aided in preventing the spread of the disease to other patients. The sloughs must be carefully trimmed away with the scissors or scalpel, and the bromine applied directly to the surface. Many cases of failure were at first found to be due to the fact that the application was made on the outside of impenetrable sloughs, and failed to reach the real seat of the disease. The bromine may be applied by a stiff brush or a mop made of cotton or charpie. If there are pockets, the drug must be injected into them with a syringe. After this

injection all odor ceases, the part shrinks, and healing goes on, if at the same time the general health be attended to. The cauterization need not be repeated except at points where the disease seems not to have been reached, but a dilute solution of bromine may be used for several days. The solution recommended by Dr. Goldsmith is as follows:

℞. Bromini ..... 32 grammes.
Potass. brom..... 10 "
Aquæ dest.....q.s. ad. 128 "
M.

This solution can be used in any required dilution according to the necessities of the case, and for suppurating wounds in general a solution of about one-eighth the strength given here will be found of the highest utility. It is not poisonous like the bichloride of mercury or carbolic acid, and is in practice equally effective as a germicide. The solution of bromine diluted for individual cases should always be preferred for deep injections, where there is danger of absorption of a poisonous quantity of the mercury solution.

In addition to the local and constitutional remedies, fresh air should be freely admitted, and all other patients promptly removed from the source of contagion. The prompt isolation of the first case of hospital gangrene occurring in a ward, is essentially necessary, not only to prevent the infection of the other wounded patients, but as an important element in the treatment. Nourishing food, and an antiscorbutic diet are properly regarded as necessary adjuncts to any course of local treatment that may be adopted. *John B. Hamilton.*

[1] U. S. Marine Hospital Reports, 1882, pp. 160–162.

GARGLES (from γαργαρίζω, to gargle, a word resembling in sound the act indicated) are liquid medicines used in washing the mouth and throat; in the latter case being held in the fauces and agitated by air expelled from the larynx.

A gargle may consist of water alone, or of water or other liquid holding in solution mineral or vegetable substances, and may be employed for simply cleansing the parts, or for therapeutic purposes. The term is, moreover, commonly restricted to liquids applied to the throat by the act of gargling, while those used in the mouth alone are usually designated as mouth-washes.

In former times gargles were used without much discrimination in all affections of the throat, varied, of course, in their composition according to the indications of the case in hand; and, indeed, they are so used to a considerable extent at the present day. But since the invention of the laryngoscope and rhinoscope this practice has measurably declined. These instruments, and the more careful study which they have rendered possible, have led to more exact methods of treatment in throat affections, and consequently gargles, whose application must necessarily be made rather loosely, are falling into disfavor. Some of the most prominent laryngologists, among them Morrell Mackenzie, restrict their use entirely to affections of a chronic character, and situated not farther back than the anterior pillars of the fauces, holding that the pain induced by their employment in acute affections more than counterbalances any benefit derived. It seems to me, however, that this restriction is quite too stringent. We must take patients as we find them, and prescribe remedies, often because of their availability rather than that they are the best. Comparatively few patients are so situated as to admit of all the care required to produce the best results of treatment. Of those suffering from the lighter forms of throat affections, whether acute or chronic, this remark is especially true; and in such cases gargles will continue to be prescribed and used, even though more exact and efficient methods might yield better results. And regarding their rejection in acute and painful affections of a graver character, such as tonsillitis, diphtheria, and the sore-throat of scarlet fever, notwithstanding the dictum of high authority, I believe that a large body of the profession, confirmed in their opinion by the results of their experience and observation, will continue to employ them, and, I think, too, with satisfaction to themselves and benefit to their patients.

In a considerable proportion of cases gargles are, of course, inadmissible, either on account of the tender age of the patient, or because of their use occasioning nausea and perhaps vomiting.

Gargles may be classified in a general way as stimulant, astringent, sedative, and antiseptic, though, naturally, such a classification is quite arbitrary, since an individual one may be at the same time both sedative and antiseptic, or astringent and antiseptic, as the case may be. This classification is, however, convenient in practice, and most practitioners recognize it whether formulated or not.

Gargles are unofficinal preparations—that is, not recognized by the various national pharmacopœias, though many hospitals and public institutions have adopted formulæ for their own convenience. Below are given some of the formulæ in use in the London Throat Hospital:

℞. Acetic acid ..... 15 minims.
Glycerin ..... 18 minims.
Water.....to 1 ounce.
Mix. Stimulant and antiseptic. Very useful in the subacute inflammatory affections occurring during the course of the exanthemata. (Acetic acid, Br. Ph., is about one-fourth weaker than that of the U. S. Ph.)

℞. Carbolic acid ..... 2 grains.
Glycerin ..... 24 minims.
Water.....to 1 ounce.
Mix. Stimulant and antiseptic.

℞. Dilute hydrochloric acid..... 12 minims.
Glycerin ..... 24 minims.
Water.....to 1 ounce.
Mix. Stimulant.

℞. Tannic acid..... 360 grains.
Gallic acid ..... 120 grains.
Water ..... 1 ounce.
Rub the acids to a fine powder and mix with the water. This preparation is most useful for arresting hæmorrhage from the uvula or tonsils after excision; the patient should be directed to sip the mixture slowly, or hold it passively in the mouth till the hæmorrhage is stopped. It should be made fresh, in quantities as required.

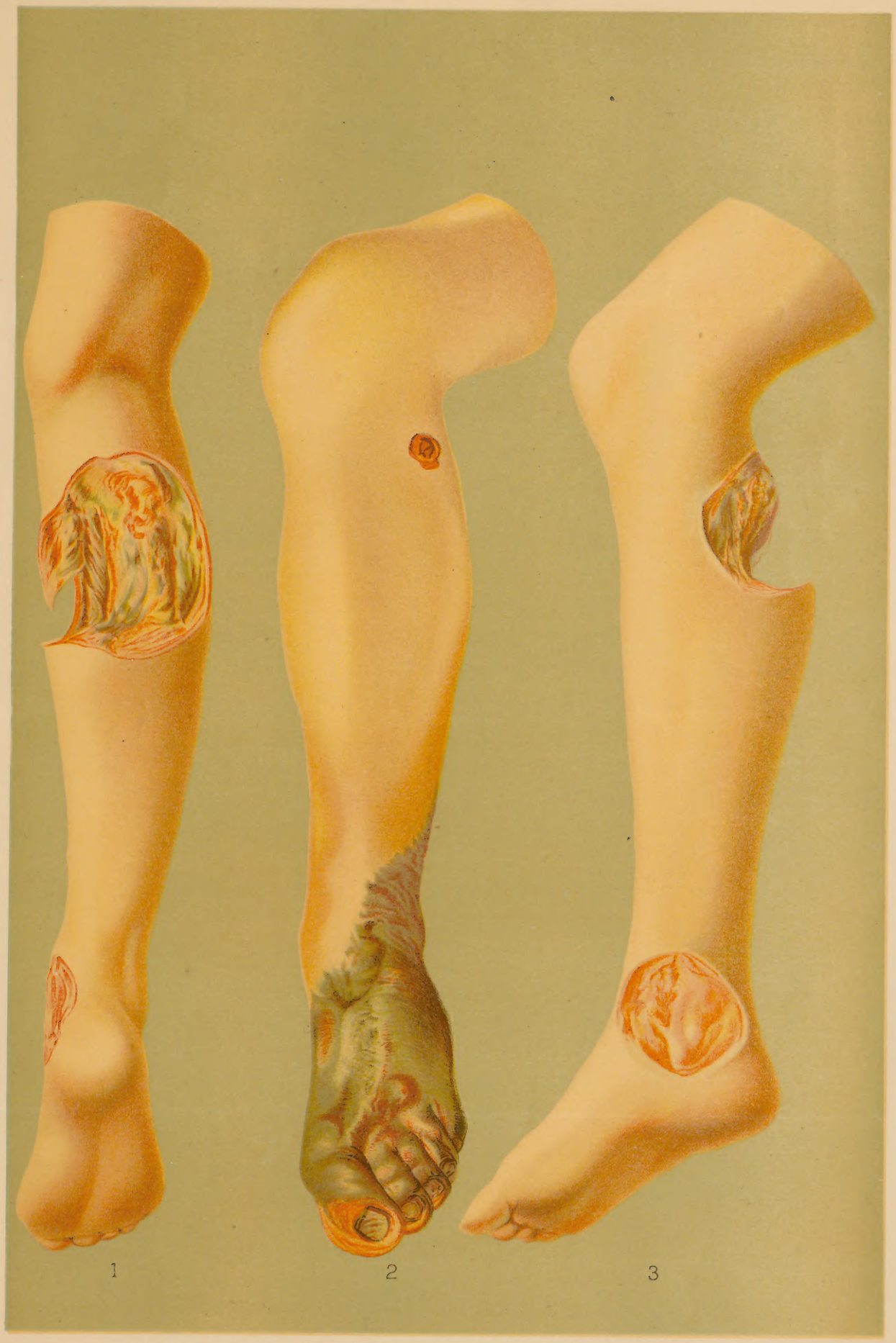
℞. Borax..... 24 grains.
Glycerin ..... 24 minims.
Tincture of myrrh ..... 24 minims.
Water.....to 1 ounce.
Mix. Mild alkaline astringent.

℞. Solution of chlorinated soda... 24 minims.
Water.....to 1 ounce.
Mix. Disinfectant. Very useful in sloughing phagedena and putrid conditions of the throat.

The above will serve as illustrations of published formulæ of gargles; the list might be added to almost indefinitely. Hot and cold water, solutions of alum, chlorate of potash, sulphate of zinc, chloride of iron, and mixtures of water with compound tincture of benzoin, tincture of guaiac, tincture of opium, etc., are often used for purposes which will readily suggest themselves to the reader. Lime-water—on account of its solvent action on membranous exudation—sage-tea alone, or with alum for astringent effect, mucilaginous liquids, as infusions of flax-seed and slippery-elm, and many other preparations of similar character, are in common use.

Laurence Johnson.

GARLIC (*Allium*, U. S. Ph.; *Ail*, Codex Med.). The bulb of *Allium Sativum* Linn. Order *Liliaceæ*, consisting of several bulblets, "cloves," enclosed in a common envelope, is still retained in the Pharmacopœia with no very good reason, and prepared in the form of a syrup, (*Syrupus Allii*, U. S. Ph.), consisting of garlic 15, sugar



FIGS. 1 AND 3. SHOWING EFFECTS OF HOSPITAL GANGRENE.
FIG. 2. GANGRENE OF FOOT AFTER SHOTWOUND OF LEG.
(FROM THE MEDICAL AND SURGICAL HISTORY OF THE WAR OF THE REBELLION.) H. BENOKE, LITH. N.Y.

GANGRENE FOLLOWING A SHOT LACERATION OF THE FEMORAL ARTERY.

(FROM THE MEDICAL AND SURGICAL HISTORY OF THE WAR OF THE REBELLION.)

H. BENCKE, LITH. N.Y.